STATE & PRIVATE FORESTRY
FOREST HEALTH PROTECTION
SOUTH SIERRA SHARED SERVICE AREA

Report SSSA 12-02

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SUBJECT: **Callecat Ecological Restoration Project**
Amador Ranger District, Eldorado National Forest

In the company of Amador Ranger District silviculturist and forester (Robert Carroll and Marc Young), FHP South Sierra Service Area (Martin MacKenzie and Beverly M. Bulaon) made a visit to view proposed units of Callecat Ecological Restoration Project. Several photographs taken on that visit were used to develop a specific biological evaluation and recommendations. This evaluation is supported by five years of observations made in comparable projects in similar white fir tree zones on the Eldorado, Stanislaus, Sierra, and Sequoia National forests.

Anatomy of root disease pockets as they relate to Callecat Project

Root disease in the western Sierra Nevada typically develops as a pocket in stands dominated by a single (host) species. Root systems of white fir (*Abies concolor*) trees tend to graft together upon contact, which explains why many stumps of this species remain alive after thinning operations. Figure 1 (below) shows a white fir stump that remained alive because it was root grafted to adjacent living fir trees. Reaching into the decay cavity, a *Heterobasidion occidentale*[1] conk was discovered. Thus, *Heterobasidion* fungus growing in this stump has continually been producing spores because root systems of adjacent trees have kept it alive. Stumps dating back to salvage logging from the 1950's have also been found with fresh conks. By growing down the root system, through the graft and into the butt of the adjacent tree the fungus that began as a root disease becomes a but rotter in what is essentially a communal root system.

[1] Until very recently forest pathologists recognized two forms of the fungus *Heterobasidion annosum* that causes Annosum root disease. The true fir form of Annosum root disease was caused by the "S" type of the fungus and the pine form of the disease was caused by the "P" type. However, in 2009 Otrosina and Garbelotto created 2 new species names; *H. occidentale* for the fir form and *H. irregulare* for the pine disease. The common name for the disease will become known as Heterobasidion root disease. We now have two fungi but still only one disease. While this is a mycological distinction it does not change the biology of the disease, it's just one more name to remember.

Figure 1. *A living white fir stump. After thinning, residual trees can effectively increase their individual root systems by co-opting root systems of thinned trees; however, trees that share a root system run the risk of sharing disease.*

Figure 2 shows how *Heterobasidion* spreads either aerially or via root grafts. Aerial spread is inefficient as millions of spores need to be produced then dispersed over a long period of time, as well as a fresh cut stump or open wound for spores to land and establish on. If a stump is grafted to a living tree, fungi can establish with sufficient food supplies to produce even more spores, thereby continuing the cycle.

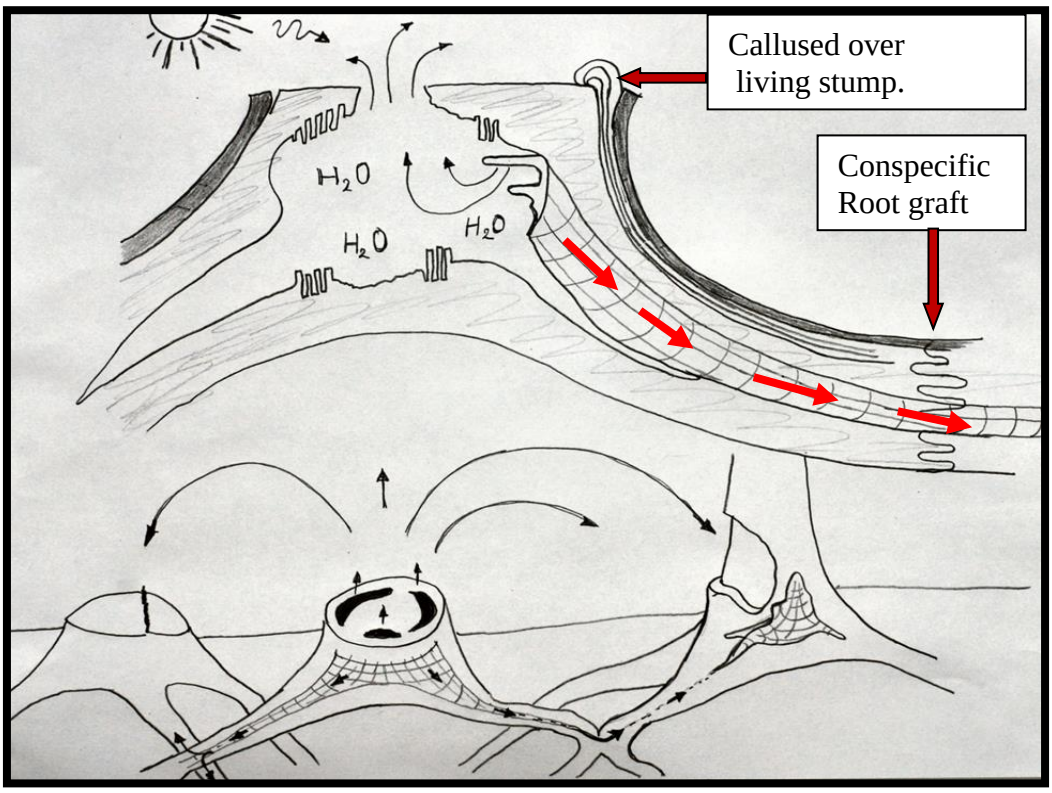


Figure 2. *Graphic depiction of Heterobasidion distribution in a grafted white fir stand.*

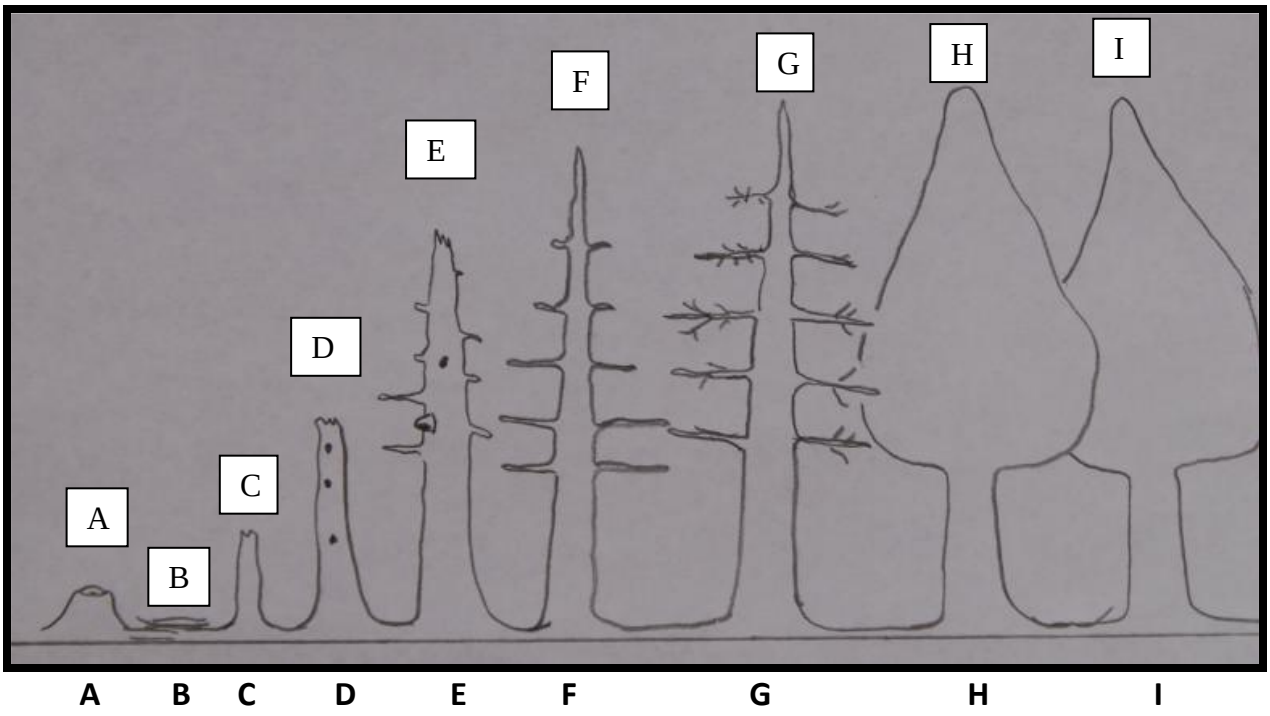


Figure 3. *Schematic drawing of classical root disease expansion with various stages described in the caption. The anatomy of a classic root disease pocket has the following (more or less) concentric zones.*

A. Focal point where fungus initially infested the stand. This initial infection may have taken place decades ago.
B. Long dead wood now contributing to the soil organic layer.
C. Very short spar, eroding back to eventually give the appearance of being a stump. In later stages, all that may be left is a depression in the ground.
D. Tall spar with no branches (eroded back earlier). These trees may show signs of having been used as dens for wildlife species.
E. Active wildlife trees that may contain decay conks.
F. Dead trees with full branches but no needles.
G. Dead trees with full branches and dead needles.
H. Infested but perhaps asymptomatic tree. Frequently trees in this state are under water stress because of compromised root systems, increasing the risk of bark beetle attack. At endemic levels, bark beetles preferentially attack these trees.
I. Beyond tree H would be healthy peripheral trees.

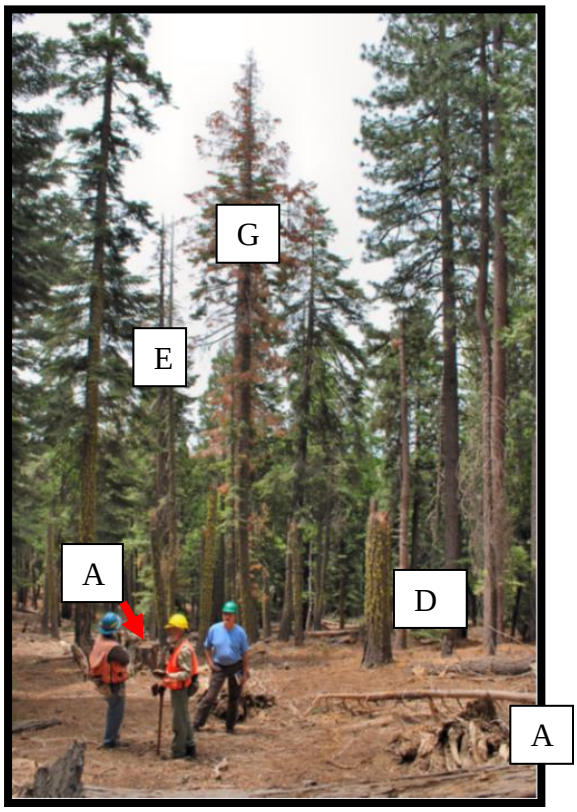


Figure 4. *Typical root disease pocket in a white fir stand on Callecat project.*

Figure 4 represents a view of a typical root disease pocket observed on Callecat project. A single stump (A) is arrowed and the decayed bases of naturally infested stems (stump equivalents) are also coded (A). Short spars (D), dead trees with no branches (E) and red trees (dead but with needles still attached = G). The boxed letters refer back to the classical concept (Figure 3). This typical root disease center highlights the fact that perfect concentric rings are not often visible (Figure 3).

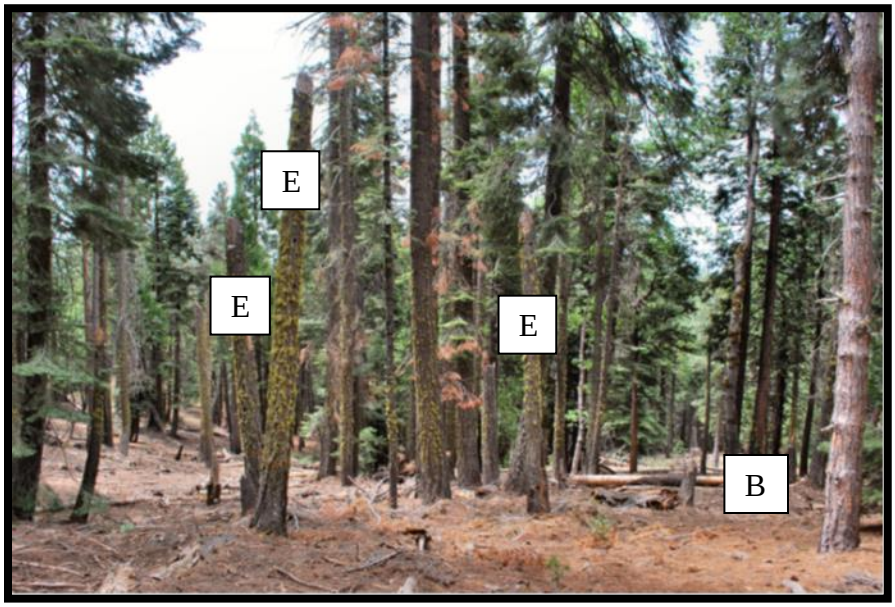


Figure 5. *The view from the outer edge of one root rot pocket. Spars (E) with conks and wildlife cavities.*

Figure 5 displays another root rot pocket but highlights slightly different biological aspects. Walking through Callecat project area, we were able to see one root rot pocket next to another. We noticed islands of healthy fir interspersed between expanding root rot pockets. In other project evaluations where we have encountered similar levels of *Heterobasidion* disease, some people have suggested this fungus is so ubiquitous due to a communal root system that borate-prevention treatments would have no effect. As a sign in a dentist office once read, "You do not have to floss all your teeth, only the ones you want to keep!" We maintain you do not have to Sporax all your stumps only those next to trees you hope to keep.

Figure 6 highlights more aspects of disease biology of *Heterobasidion*. One of the problems with root disease is that dead trees do not stand upright as wildlife trees as long as trees killed by other causes. Because the fungus decays the butt and roots long before the tree dies, its root system is unable to anchor the tree in place. A close up of the marked "stump" in figure 6 is provided as Figure 7.

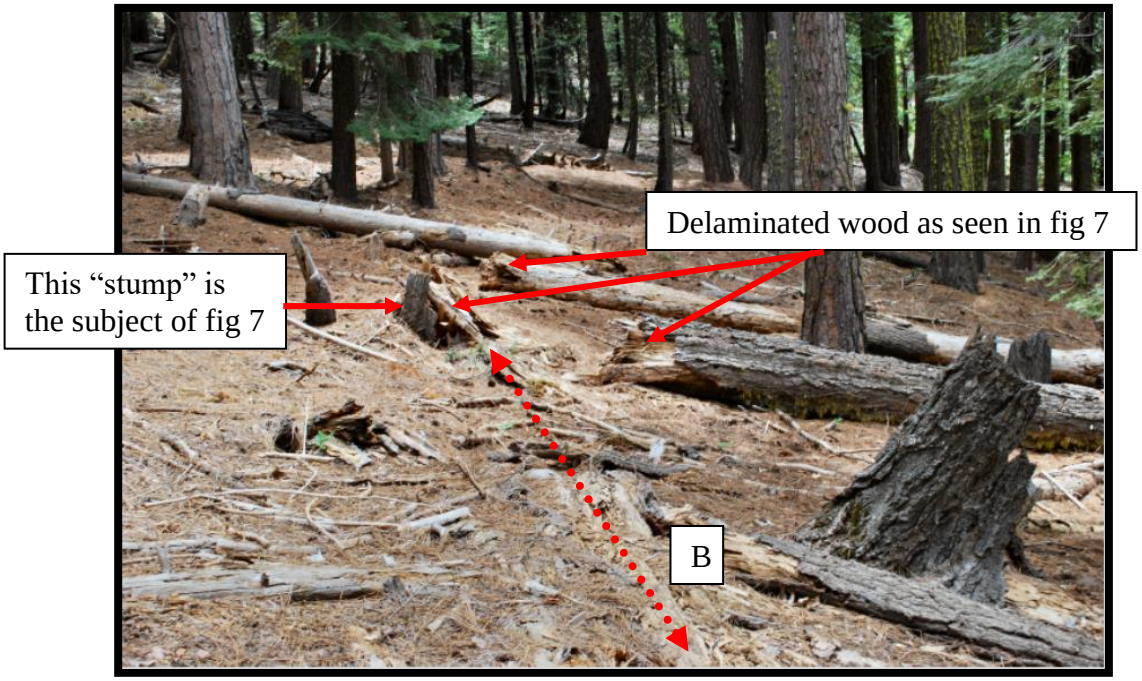


Figure 6. *Showing the "stump" that is the focus of Figure 7*

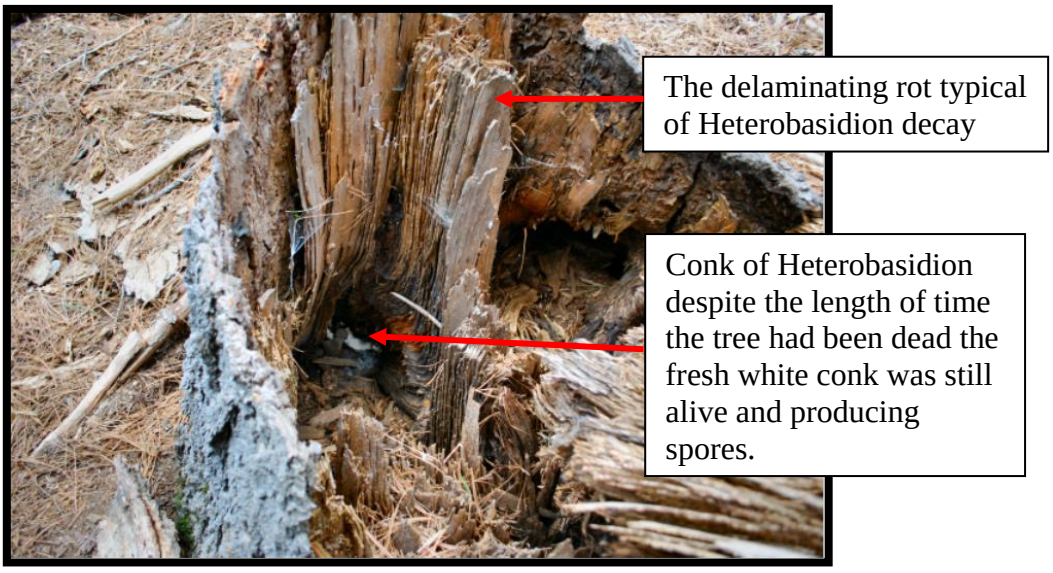
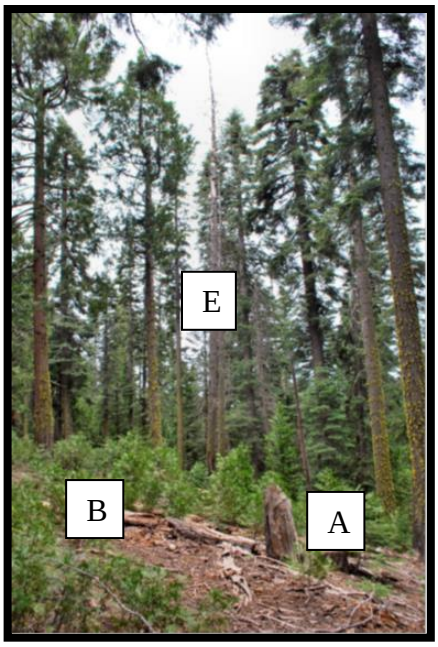


Figure 7. *The "stump" that is the focus of the center in figure 6*

Prognosis for the Heterobasidion epidemic

Figures 1 through 7 were provided as a photo essay to build the case that much of the proposed units of Callecat Project are currently experiencing an epidemic of *Heterobasidion* root disease. Two different outcomes often result where fir dominated stands experience *Heterobasidion* epidemics: either the stand will regenerate as predominantly true fir or the stand converts to incense cedar-dominant. The image below (Figure 8), support this point. In some cases we have seen examples where the stand returns as healthy white fir regeneration. As the thickets of fir regeneration gives way to maturing pole-sized trees, the root systems of the firs expand and start connecting con-specific root to root grafts. When inter-tree competition becomes severe, weaker trees become targets of fir engraver attacks (*Scolytus ventralis*). If a salvage cut is made to recover the volume in these killed trees and a borate-compound treatment on cut stumps is not deployed, *Heterobasidion* spores can infect the cut (but grafted stumps); thus the disease cycle begins over again.



Even though a previous salvage had been converted to a pine plantation, we saw evidence (Figure 9) that decades later the fir stumps were still capable of producing spores, and thus a stand that had already been converted to pine was still able to threaten the continued health of any adjacent thinned fir stands.

Figure 8. *Although this may look like an old root disease pocket, it is an opportunity for incense cedar.*

Figure 9. *Although the stand has been converted to pine, Heterobasidion threat has not gone away. As long as the top of the stump stays intact conks will not dry out and will continue to produce spores as long as their mycelial system has cellulose to digest.*

The consequences of the do nothing option in the ongoing Heterobasidion epidemic in the Callecat Project.
The ongoing Heterobasidion root disease epidemic will prevent tree from reaching their potential maximum size, of the disease has the potential to kill them before they reach that size. If it is the objective of management is to manage for old growth character this objective can not be obtained by doing nothing. The standing dead trees in images 4 through 8 do not have old growth character; they all died while in their prime. While walking the project we frequently found stumps from earlier thinnings or salvage after insect or fungal attacks that had a larger diameter than any living tree. As these areas (outside plantations) were not previously clearcut stands it is logical to assume that insects, diseases or combinations of the two had already killed the largest trees. Unlike exotic diseases and insects, coevolved (native) diseases or insects generally do not eliminate their host. When Heterobasidion root disease opens up pockets in a white fir dominated stand the species to recolonize there spots is most frequently white fir. The seedlings will grow up to become poles and as they mature their root systems will expand and when they come into contact with one another they will graft thus reestablish the communal root system that is so beneficial to the Heterobasidion fungus. On some of the drier sites where there may be an incense cedar seed source, this species might out compete the white fir (see image 8). The disease will never eliminate white fir but it has the potential to keep that stands from ever developing that old growth character we are managing for.

Recommended prescription for ongoing Heterobasidion epidemic in the Callecat Project
While we have spent some time developing the case that Callecat Project is in the grips of *Heterobasidion* root disease epidemic, our prescription is simple: follow Forest Service Regional guidelines concerning root disease and apply an approved borate treatment to all cut stumps that guidelines recommend.

The regional office has spent a considerable amount of resources in times of both money and specialists time to come up with a set of biologically defensible guidelines to combat the kind of epidemic we saw in the Callecat Project area. As your Pathologist and Entomologist we can not improve on this prescription and we would be acting unprofessional if we to suggest that there were any other biologically sound option. As can be seen from the web based documentation below there is wealth of information to aid in the NEPA documentation of the use of Sporax. There is a white paper that should be considered prior to beginning a project-NEPA document. This white paper can be found at: http://www.fs.fed.us/r5/spf/fhp/pesticide/index.shtml It is referred to as the pesticide use advisory memorandum 06-01 (two documents on the web page, the cover letter and the attachment (which is the white paper). The attachment responds to Issues Raised by CATs Concerning Borax (Sporax®) and was authored by David Bakke, Regional Pesticide-Use Specialist. There is also a national risk assessment for "Borax" fungicides that discusses human as well as ecological health risks, located on-line at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Heterobasidion Information http://www.fs.fed.us/r5/spf/fhp/heterobasidion.shtml

- R5 Insect & Disease Manual: *Heterobasidion* (pdf 1.9 MB)
- Forest Health Protection Handbook, FSH 3409.11, Chapter 60 (pdf 98 KB)
- Otrosina Heterobasidion taxonomy paper (pdf 1.5 MB)
- Excerpt from *CA Forest Pest Conditions 2009: Heterobasidion* (pdf 2.4 MB)
- Proceedings of the Symposium on Research and Management of Annosus Root Disease (*Heterobasidion annosum*) in Western North America (pdf 1.5 MB)
- Cellu-Treat Information, Product Label, and Material Safety Data Sheets (pdf 356 KB)
- Sporax® Information, Product Label, and Material Safety Data Sheets (follow link, type Sporax into the Brand Name box, click search)
- Human Health and Ecological Risk Assessment for Borax (pdf 621 KB)
- Borax: Frequently Asked Questions (pdf 110 KB)
- Borax Application Training Presentation (pdf 1 MB)
- Written Training Plan for Borax Applicators (pdf 97 KB)
- Region 5 Pesticide-Use Advisory Memorandum 06-01 - Issues with Using Borax for Annosus Root Disease Prevention (pdf 19 KB)
- Attachment to R5 Pesticide-Use Advisory Memorandum 06-01 - Responding to Issues Raised by CATs Concerning Borax (Sporax®) (pdf 392 KB)

Alternative Options for Stump Treatment:

It is our considered opinion that there are no non-borate options to the major forest health problem of the Callecat project. However, Sporax™ is no longer the only option available in California; Cell-Treat™ is a liquid formulation that is now an alternative to the granular Sporax formulation.

If the district requires more information or has any questions regarding this report, please do not hesitate to contact us.

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References

Provided electronically at http://www.fs.fed.us/r5/spf/fhp/heterobasidion.shtml